

Application Number 09/851,363
Amendment in Response to final Office Action mailed July 23, 2007

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AMENDMENTS TO THE CLAIMS

This listing of claims will replace all prior versions and listings of claims in the application.

Listing of Claims:

Claim 1 (Currently amended): A routing device comprising:

a plurality of removable interface cards to communicate packets using a network; and
a router module separate from the plurality of removable interface cards, the router module comprising a packet forwarding engine, memory, a memory management unit, and an interface card concentrator module, wherein the interface card concentrator couples the packet forwarding engine to the plurality of removable interface cards wherein the packet forwarding engine, memory management unit, and the interface card concentrator module are integrated into a single unit,

wherein the interface card concentrator module receives ~~communicates~~ packets from at least two of the removable interface cards ~~to the packet forwarding engine,~~

wherein contents of the received packets are stored in the memory,

wherein the memory management unit generates notifications based on keys of the received packets and forwards the notifications to the packet forwarding engine,

wherein the packet forwarding engine performs route lookups for the packets based on the keys in response to the notifications, and

wherein the interface card concentrator module sends the packets from the memory to the removable interface cards as output bound packets based on the route lookups performed by the packet forwarding engine in response to the notifications, received from the at least two removable interface cards by way of the interface card concentrator module, and wherein the packet forwarding engine selects routes for the packets and forwards the packets back to the plurality of removable interface cards via the interface card concentrator module, and
~~wherein the packet forwarding engine and the interface card concentrator module are integrated into a single unit.~~

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Claim 2 (Previously Presented): The routing device of claim 1, further comprising a midplane coupled between the plurality of removable interface cards and the router module and separating the plurality of removable interface cards from the router module.

Claims 3- 5 (Cancelled).

Claim 6 (Currently amended): The routing device of claim 1, ~~claim 5~~, wherein the interface card concentrator assembles the output bound packets from data stored in the memory and forwards the output bound packets to the plurality of removable interface cards.

Claim 7 (Currently amended): The routing device of claim 1, ~~claim 5~~, wherein the interface card concentrator processes inbound packets received from the plurality of removable interface cards to remove the keys ~~labels~~ from the inbound packets, and stores data from the processed inbound packets in the memory.

Claim 8 (Currently amended): The routing device of claim 1, ~~claim 5~~, wherein the memory comprises an SDRAM device.

Claim 9 (Cancelled).

Claim 10 (Currently amended): The routing device of claim 1, ~~claim 9~~, wherein the notifications are generated based on extracted information that includes at least one of source address information, destination address information, source port information, and destination port information.

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Claim 11 (Previously Presented): The routing device of claim 9,
wherein the packet forwarding module is configured to select the routes for the packets received from the at least two different ones of the plurality of removable interface cards by referencing a forwarding table based on the extracted information, and
wherein the forwarding table stores the route information for forwarding data packets received from any of the plurality of removable interface cards.

Claim 12 (Previously Presented): The routing device of claim 11, further comprising a routing engine to store a routing table.

Claim 13 (Currently amended): The routing device of claim 11, further comprising another memory to store the forwarding table.

Claim 14 (Currently amended): The routing device of claim 11, wherein the memory management circuit is configured to forward the packets ~~the incoming data packet~~ to ~~one~~ of the plurality of removable interface cards based on the selected route.

Claim 15 (Previously Presented): The routing device of claim 1, further comprising a redundant router module to process the data packets and to forward the data packets between the removable interface cards in response to malfunction of the router module.

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Claim 16 (Currently amended): A routing device comprising:

- a plurality of interface cards to communicate data packets using a network;
- a router module comprising a packet processing circuit, a memory management circuit, memory, and a route lookup circuit integrated into a single module separate from the plurality of interface cards; and
- a midplane coupled to the router module and to the plurality of interface cards, wherein the midplane communicates to the router module packets received from the network by at least two different ones of the interface cards, and
- wherein the packet processing circuit receives packets from at least two of the removable interface cards,
- wherein contents of the received packets are stored in the memory,
- wherein the memory management circuit generates notifications based on keys of the received packets and forwards the notifications to the packet forwarding engine,
- wherein the packet forwarding engine performs route lookups for the packets based on the keys in response to the notifications, and
- wherein the interface card concentrator module sends the packets from the memory to the removable interface cards as output bound packets based on the route lookups performed by the packet forwarding engine in response to the notifications.
- ~~wherein the router module performs route lookups for the packets received from the at least two different ones of the interface cards to select routes for the packets and forward the packets back to the interface cards in accordance with route information associated with the network.~~

Claim 17 (Original): The routing device of claim 16, wherein the single module comprises a single printed circuit card that interconnects the packet processing circuit, the memory management circuit, and the route lookup circuit.

Claim 18 (Cancelled).

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Claim 19 (Currently amended): The routing device of claim 16, ~~claim 18~~, wherein the memory management circuit is configured to provide packet data to the packet processing circuit.

Claim 20 (Currently amended): The routing device of claim 16, ~~claim 18~~, wherein the memory is further configured to store outbound data.

Claim 21 (Currently amended): The routing device of claim 16, ~~claim 18~~, wherein the memory comprises an SDRAM device.

Claim 22 (Cancelled).

Claim 23 (Currently amended): The routing device of claim 16, ~~claim 22~~, wherein the notifications are generated based on extracted information that includes at least one of source address information, destination address information, source port information, and destination port information.

Claim 24 (Currently amended): The routing device of claim 13, ~~claim 22~~, wherein the route lookup circuit is configured to select a route for the packets received from the at least two different ones of the interface cards by referencing a forwarding table based on the extracted information, wherein the forwarding table stores the route information for forwarding data packets received from any of the plurality of interface cards.

Claim 25 (Original): The routing device of claim 24, wherein the route lookup circuit is configured to select the route by performing a longest prefix match based on the extracted information.

Claim 26 (Previously Presented): The routing device of claim 24, further comprising a routing engine to store a routing table.

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Claim 27 (Currently amended): The routing device of claim 24, further comprising another memory to store the selected route in the forwarding table.

Claim 28 (Original): The routing device of claim 24, wherein the memory management circuit is configured to forward the incoming data packet to an interface card based on the selected route.

Claim 29 (Original): The routing device of claim 16, wherein the packet processing circuit is configured to remove an L2 header from an incoming data packet.

Claim 30 (Currently amended): The routing device of claim 16, wherein the packet processing circuit is configured to build an L2 headers for the output bound packets, ~~an~~ ~~outbound data packet~~.

Claim 31 (Previously Presented): The routing device of claim 16, further comprising a redundant router module to process the data packets and to forward the data packets between the interface cards in response to malfunction of the router module.

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Claim 32 (Currently amended): A routing arrangement comprising:

- a crossbar arrangement; and
- a plurality of routing devices coupled to the crossbar arrangement, at least one routing device comprising:
 - a plurality of removable interface cards to communicate data packets using a network; and
 - a router module separate from the plurality of removable interface cards, wherein the router module performs route lookups for a first set of the data packets received from the network by a first one of the removable interface cards and for a second set of the data packets received from the network by a second one of the removable interface cards to select routes for the data packets and to forward the data packets between the removable interface cards,
 - wherein the router module comprises a system control module that performs the route lookups, memory, a memory management circuit, and at least one concentrator module that receives the data packets from at least the first one and the second one of the removable interface cards, and
 - wherein the system control module, the memory management circuit, and the concentrator module are integrated into a single unit,
 - wherein the router module receives packets from at least two of the removable interface cards,
 - wherein contents of the received packets are stored in the memory,
 - wherein the memory management circuit generates notifications based on keys of the received packets and forwards the notifications to the system control module,
 - wherein the system control module performs route lookups for the packets based on the keys in response to the notifications, and
 - wherein the concentrator module sends the packets from the memory to the removable interface cards as output bound packets based on the route lookups performed by the system control module in response to the notifications.

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Claim 33 (Previously Presented): The routing arrangement of claim 32, further comprising a midplane coupled to the plurality of removable interface cards and to the router module.

Claims 34-38 (Cancelled).

Claim 39 (Currently amended): The routing arrangement of claim 32, ~~claim 36~~, wherein the memory comprises an SDRAM device.

Claim 40 (Currently amended): The routing arrangement of claim 32, ~~claim 35~~, wherein the memory management circuit is further configured to provide the a-notifications to the system control module based on information extracted from ~~an~~-incoming data packets.

Claim 41 (Original): The routing arrangement of claim 40, wherein the extracted information includes at least one of source address information, destination address information, source port information, and destination port information.

Claim 42 (Previously Presented): The routing arrangement of claim 40, wherein the system control module is configured to select a route by referencing a forwarding table based on the extracted information, wherein the forwarding table stores the route information for forwarding data packets received from any of the plurality of removable interface cards.

Claim 43 (Previously Presented): The routing arrangement of claim 42, further comprising a routing engine to store a routing table.

Claim 44 (Previously Presented): The routing arrangement of claim 42, further comprising a memory to store the selected route in the forwarding table.

Claim 45 (Cancelled).

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Claim 46 (Original): The routing arrangement of claim 32, further comprising a redundant router module to process the data packets and to forward the data packets between the interface modules in response to malfunction of the router module.

Claim 47 (Currently amended): A routing arrangement comprising:

a crossbar arrangement; and

a plurality of routing devices coupled to the crossbar arrangement, at least one routing device comprising:

a plurality of removable interface cards to communicate data packets using a network,

a router module comprising memory and a packet processing circuit, a memory management circuit, and a route lookup circuit integrated into a single module separate from the plurality of removable interface cards, and

a midplane coupled to the router module and to the plurality of removable interface cards,

wherein the midplane communicates to the router module a first set of packets received from the network by a first one of the removable interface cards and a second set of packets received from the network by a different one of the removable interface cards, and

wherein the router module performs route lookups for the first set of packets and the second set of packets in accordance with route information associated with the network

wherein the router module receives the data packets from at least two of the removable interface cards.

wherein contents of the received data packets are stored in the memory.

wherein the memory management circuit generates notifications based on keys of the received data packets and forwards the notifications to the route lookup circuit.

wherein the route lookup circuit performs route lookups for the data packets based on the keys in response to the notifications, and

wherein the router module sends the data packets from the memory to the removable interface cards as output bound packets based on the route lookups performed by the route lookup circuit in response to the notifications.

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Claim 48 (Original): The routing arrangement of claim 47, wherein the single module comprises a single printed circuit card that interconnects the packet processing circuit, the memory management circuit, and the route lookup circuit.

Claims 49-51 (Cancelled).

Claim 52 (Currently amended): The routing arrangement of claim 47, ~~claim 49~~, wherein the memory comprises an SDRAM device.

Claim 53 (Currently amended): The routing arrangement of claim 47, wherein the memory management circuit is configured to provide the a-notifications to the route lookup circuit based on information extracted from ~~an~~ incoming data packets.

Claim 54 (Original): The routing arrangement of claim 53, wherein the extracted information includes at least one of source address information, destination address information, source port information, and destination port information.

Claim 55 (Previously Presented): The routing arrangement of claim 53, wherein the route lookup circuit is configured to select a route by referencing a forwarding table based on the extracted information, wherein the forwarding table stores the route information for forwarding data packets received from any of the plurality of removable interface cards.

Claim 56 (Original): The routing arrangement of claim 55, wherein the route lookup circuit is configured to select the route by performing a longest prefix match based on the extracted information.

Claim 57 (Original): The routing arrangement of claim 55, further comprising a routing engine to store a routing table.

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Claim 58 (Currently amended): The routing arrangement of claim 55, further comprising another memory to store the selected route in the forwarding table.

Claim 59 (Cancelled).

Claim 60 (Original): The routing arrangement of claim 47, wherein the packet processing circuit is configured to remove an L2 header from an incoming data packet.

Claim 61 (Currently amended): The routing arrangement of claim 47, wherein the packet processing circuit is configured to build ~~an~~ L2 headers and rewrite ~~an~~ L3 headers for the output bound packets. ~~an outbound data packet.~~

Claim 62 (Original): The routing arrangement of claim 47, further comprising a redundant router module to process the data packets and to forward the data packets between the interface modules in response to malfunction of the router module.

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Claim 63 (Currently amended): A router comprising one hardware board integrally housing an interface concentrator that provides electrical interfaces to receive incoming packets from a plurality of interface cards, a packet processing circuit, memory, a memory management circuit, and a route lookup circuit separate from the interface cards to perform route lookups to select routes for a first packet and a second of the incoming packets received from a network by different ones of the plurality of interface cards

wherein the interface concentrator receives the data packets from at least two of the interface cards,

wherein contents of the received data packets are stored in the memory,

wherein the memory management circuit generates notifications based on keys of the received data packets and forwards the notifications to the route lookup circuit,

wherein the route lookup circuit performs route lookups for the data packets based on the keys in response to the notifications, and

wherein the interface concentrator sends the data packets from the memory to the interface cards as output bound packets based on the route lookups performed by the route lookup circuit in response to the notifications.

Claim 64 (Original): The router of claim 63, wherein the memory management circuit is configured to provide incoming data to the packet processing circuit.

Claim 65 (Previously Presented): The router of claim 63, wherein the memory management circuit is configured to provide a notification to the route lookup circuit based on information extracted from the incoming data packets.

Claim 66 (Previously Presented): The router of claim 65, wherein the extracted information includes at least one of source address information, destination address information, source port information, and destination port information for each of the incoming packets.

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Claim 67 (Previously Presented): The router of claim 65, wherein the route lookup circuit is configured to select the routes by referencing a forwarding table based on the extracted information, wherein the forwarding table stores the route information for forwarding data packets received from any of the plurality of interface cards.

Claim 68 (Original): The router of claim 67, wherein the route lookup circuit is configured to select the route by performing a longest prefix match based on the extracted information.

Claim 69 (Original): The router of claim 63, wherein the packet processing circuit is configured to remove an L2 header from an incoming data packet.

Claim 70 (Currently amended): The router of claim 63, wherein the packet processing circuit is configured to build ~~an~~ L2 headers and rewrite ~~an~~ L3 headers for an the output bound packets. ~~outbound data packet.~~

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Claim 71 (Currently amended): A method of manufacturing a routing device, the method comprising:

providing a plurality of interface modules to communicate data packets using a network;
coupling a midplane to the plurality of interface modules; and
coupling a single router module to the midplane,

wherein the router module is configured to perform route lookups for data packets received from different ones of the interface modules via the midplane to select routes for the packets in accordance with route information associated with the network and forward the packets back to the interface modules by way of the midplane, and

wherein the router module comprises a system control module, memory, a memory management unit, and at least one concentrator module integrated into a single unit separate from the interface modules

wherein the concentrator module receives the data packets from at least two of the interface cards,

wherein contents of the received data packets are stored in the memory.

wherein the memory management circuit generates notifications based on keys of the received data packets and forwards the notifications to the system control module,

wherein the system control module performs route lookups for the data packets based on the keys in response to the notifications, and

wherein the interface concentrator module sends the data packets from the memory to the interface cards as output bound packets based on the route lookups performed by the system control module in response to the notifications.

Claim 72-76 (Cancelled).

Claim 77 (Currently amended): The method of claim 74, further comprising configuring the memory management circuit to provide the a-notifications to the system control module based on information extracted from ~~an~~ incoming data packets.

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Claim 78 (Previously Presented): The method of claim 77, further comprising configuring the system control module to select a route by referencing a forwarding table based on the extracted information, wherein the forwarding table stores the route information for forwarding data packets received from any of the plurality of interface modules.

Claim 79 (Currently amended): The method of claim 78, further comprising configuring a routing engine to store a the routing table.

Claim 80 (Original): The method of claim 71, further comprising configuring a redundant router module to process the data packets and to forward the data packets between the interface modules in response to malfunction of the router module.

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Claim 81 (Currently amended): A method of manufacturing a routing device, the method comprising:

- providing a plurality of interface cards to communicate data packets using a network;
- providing a routing module separate from the plurality of interface cards;

and

- coupling the router module comprising a packet processing circuit, memory, a memory management circuit, and a route lookup circuit integrated into a single module to the plurality of interface cards via a midplane,

- wherein the router module is configured to perform route lookups for the data packets received from different ones of the plurality of interface cards to select routes for the packets in accordance with route information associated with the network and forward the packets back to the interface modules by way of the midplane,

- wherein the packet processing circuit receives the data packets from at least two of the interface cards,

- wherein contents of the received data packets are stored in the memory.

- wherein the memory management circuit generates notifications based on keys of the received data packets and forwards the notifications to the route lookup circuit.

- wherein the route lookup circuit performs route lookups for the data packets based on the keys in response to the notifications, and

- wherein the packet processing circuit sends the data packets from the memory to the interface cards as output bound packets based on the route lookups performed by the route lookup circuit in response to the notifications.

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Claim 82 (Currently amended): A method of manufacturing a routing arrangement, the method comprising:

providing a crossbar arrangement; and

coupling a plurality of routing devices to the crossbar arrangement, at least one routing device comprising:

a plurality of interface cards to communicate data packets using a network; and

a router module separate from the plurality of interface cards to process the data packets and to forward the data packets between the interface cards,

wherein the router module is configured to perform route lookups for the data packets received from different ones of the interface cards to select routes for the packets in accordance with route information associated with the network, wherein the router module includes a packet processing circuit, memory, a memory management circuit, and a route lookup circuit integrated into a single module,

wherein the packet processing circuit receives the data packets from at least two of the interface cards,

wherein contents of the received data packets are stored in the memory,

wherein the memory management circuit generates notifications based on keys of the received data packets and forwards the notifications to the route lookup circuit,

wherein the route lookup circuit performs route lookups for the data packets based on the keys in response to the notifications, and

wherein the packet processing circuit sends the data packets from the memory to the interface cards as output bound packets based on the route lookups performed by the route lookup circuit in response to the notifications.

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Claim 83 (Currently amended): A method of manufacturing a routing arrangement, the method comprising:

providing a crossbar arrangement; and

coupling a plurality of routing devices to the crossbar arrangement, at least one routing device comprising:

a plurality of interface cards to communicate data packets using a network,

a midplane coupled to the plurality of interface cards,

a router module coupled to the midplane to receive the data packets from the midplane prior to route selection,

wherein the router module comprises a packet processing circuit, memory, a memory management circuit, and a route lookup circuit integrated into a single module separate from the plurality of interface cards, and

wherein the router module is configured to perform route lookups for the data packets received from different ones of the interface cards to select routes for the packets in accordance with route information associated with the network, and to forward the packets back to the interface cards via the midplane,

wherein the packet processing circuit receives the data packets from at least two of the interface cards,

wherein contents of the received data packets are stored in the memory.

wherein the memory management circuit generates notifications based on keys of the received data packets and forwards the notifications to the route lookup circuit.

wherein the route lookup circuit performs route lookups for the data packets based on the keys in response to the notifications, and

wherein the packet processing circuit sends the data packets from the memory to the interface cards as output bound packets based on the route lookups performed by the route lookup circuit in response to the notifications.

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Claim 84 (Currently amended): A routing arrangement comprising:

a plurality of routing devices coupled in a crossbar arrangement, at least one routing device comprising:

a plurality of interface modules to communicate data packets using a network,

and

a router module to receive the data packets from at least two different ones of the interface modules, wherein the router module is configured to perform route lookups for the data packets received from the at least two interface modules to select routes for the packets in accordance with route information associated with the network; and

a switch arrangement coupled to the plurality of routing devices and configured to switch control from a first routing device to a second routing device, wherein the router module includes a packet processing circuit, memory, a memory management circuit, and a route lookup circuit integrated into a single module,

wherein the packet processing circuit receives the data packets from at least two of the interface cards,

wherein contents of the received data packets are stored in the memory,

wherein the memory management circuit generates notifications based on keys of the received data packets and forwards the notifications to the route lookup circuit,

wherein the route lookup circuit performs route lookups for the data packets based on the keys in response to the notifications, and

wherein the packet processing circuit sends the data packets from the memory to the interface cards as output bound packets based on the route lookups performed by the route lookup circuit in response to the notifications.

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Claim 85 (Currently amended): A routing arrangement comprising:

a plurality of routing devices coupled in a crossbar arrangement, at least one routing device comprising:

a plurality of interface cards to communicate data packets using a network,

a router module comprising a packet processing circuit, memory, a memory management circuit, and a route lookup circuit integrated into a single module separate from the plurality of interface cards and a routing engine, and

a midplane coupled to the router module and to the plurality of interface cards to provide data packets from the interface cards to the router module,

wherein the router module is configured to perform route lookups for the data packets received from any of the interface cards to select routes for the packets in accordance with route information associated with the network and forward the packets back to the interface cards by way of the midplane; and

a switch arrangement coupled to the plurality of routing devices and configured to switch control from a first routing device to a second routing device,

wherein the packet processing circuit receives the data packets from at least two of the interface cards,

wherein contents of the received data packets are stored in the memory,

wherein the memory management circuit generates notifications based on keys of the received data packets and forwards the notifications to the route lookup circuit,

wherein the route lookup circuit performs route lookups for the data packets based on the keys in response to the notifications, and

wherein the packet processing circuit sends the data packets from the memory to the interface cards as output bound packets based on the route lookups performed by the route lookup circuit in response to the notifications.

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86. (New) The routing arrangement of claim 85, wherein each of the plurality of routing devices includes a respective router module comprising a respective packet processing circuit, respective memory, a respective memory management circuit, and a respective route lookup circuit integrated into a respective single module.